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ABSTRACT

The purpose of this study was to replicate the Bentti, Golden, and Reigeluth study (1983), which explored the use of nonexamples to teach common errors as an effective strategy in teaching a procedure. A total of 24 undergraduate students enrolled in the Syracuse University Symphonic Band were randomly assigned to an experimental group and a control group. The experimental design was pretest-posttest, and two instructional booklets--one treble clef and one bass clef--were used to teach a procedure for building a musical interval up from a given note. The experimental group received instruction for the correct procedure plus reminders and examples of the most common mistakes; the control group received instruction for and examples of the correct procedure. Results showed no significant differences on an application level. The lack of significance may have been due to the fact that humans, as adaptive organisms, exert more or less effort to compensate for the quality of the instruction. Examples from the instruction booklet and posttest are included, and test scores are presented in tables and graphs. Sixteen references are provided as well as a list of prior publications in this series of working papers. (Author/MES)

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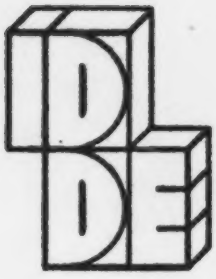

INSTRUCTIONAL DESIGN, DEVELOPMENT, AND EVALUATION

WORKING PAPERS

TEACHING COMMON ERRORS IN APPLYING A PROCEDURE

by

Alberto O. Garduno
Stephen Marcone
Charles M. Reigeluth

IDD&E Working Paper No. 18
November, 198-

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Abstract

The purpose of this study was to replicate the Bentti, Golden, and Reigeluth (1983) study, which explored the use of nonexamples to teach common errors as an effective strategy in teaching a procedure. A total of 24 undergraduate students enrolled in The Syracuse University Symphonic Band were randomly assigned to an experimental and a control group during the regular rehearsal time. The experimental design was pretest-posttest. Two insturctional booklets were used to teach a procedure for building a musical interval up from a given note. The experimental group received instruction for the correct procedure plus reminders and examples of the most often made mistakes. Results showed no significant differences on an application level posttest The authors propose that the lack of significance was due primarily to the fact that humans, as adaptive organisms, exert more or less effort to compensate for the quality of the instruction. Therefore, it is recommended that future research on the teaching of common errors by designed in such a was as to hold effort constant across groups.

During the last two decades there has been considerable research on strategies for teaching concepts One important strategy at the application level is the use of "matched" or "close in" nonexamples with examples (Merrill and Tennyson, 1977; Markle and Tiemann, 1969). Merrill and Tennyson (1977) define matched nonexamples as pairs of positive and negative instances with minimum within-pair variation of irrelevant attributes. Their relevance in instruction is to ensure that errors of overgeneralization and misconception by the learner will be avoided (Markle and Tiemann, 1969). Archer, Bourne and Brown (1955) and Brown and Archer (1956) found that nonexamples facilitate learning of concepts by requiring the subject to concentrate on a critical attribute when presented matched pairs of examples and nonexamples.

The term common error, a form of nonexample, also appears in the concept learning literature. Carnine (1980a, 1980b) found that the use of matched examples and nonexamples reduces common errors in learning, specifically overgeneralization. In identifying common errors, Klomp, Wagenaar, Kimpen (1973) and Killam, Lorton, and Schubert (1975) found a series of specific common errors in the learning of a concept.

The teaching of common errors has been proposed for learning other content types, such as procedures (Cropper, 1983), without specific research support. A literature search showed only one experiment (Dentti, Golden, and Reigeluth, 1983) on teaching common errors in applying a procedure using nonexamples matched with examples The study revealed that in an audiovisual presentation, application level learning was facilitated by the presentation of common errors in instruction In addition, Macomber (1980), in an audiovisual independent learning instruction of a procedure (for students enrolled in his Understanding Music course), did not present matched nonexamples with examples, however, he did present "the most often made mistakes", which are general statements of the common errors in each step of the procedure. Therefore, there is an inadequacy in the amount of research on matching nonexamples with examples for applying a procedure.

The following three definitions, as they apply to learning a procedure, need to be defined in order to facilitate the reader's understanding of the study.

1. A procedure is an ordered set of actions that are intended to achieve a goal (Reigeluth, Merrill, and Bunderson, 1978).

2. Common errors, a form of nonexample for procedures, are described by Macomber (1980) as the most often made mistakes.

3. A nonexample for a procedure is an example of a common error and shows a step being done incorrectly.

Given the significance of matching nonexamples with examples in the teaching of concepts, and also given the results of the Bentti, Golden, and Reigeluth (1983) study, the authors propose that preparing learners to avoid common errors in the use and application of a procedure will improve performance. The purpose of this study is to replicate the latter research (Bentti, Golden and Reigeluth, 1983) by using a different task, delivery system, and students.

The specific research question is whether or not presenting the correct performance with matched common errors will facilitate procedure learning. The independent variable is the presentation of common errors associated with the performance of a procedure. The dependent variable is the ability to perform the procedure at the application level (i e. with previously unencountered instances).

We hypothesize that students receiving presentation of the correct performance matched with the common error will perform better than students receiving only presentation of the correct performance.

Methods

Students

The students for this study were 24 (13 male and 11 female) undergraduate students enrolled in The Syracuse University Symphonic Band. Although the students were musicians (the majority were non-music majors), the results of a pretest showed that they did not have prior knowledge about the content areas used in this study. Students were randomly assigned to two groups (experimental and control) by numerical draw.

Design

The research design for this study was the pretest-posttest design (Campbell and Stanley, 1963).

Task and Materials

The task was a procedure at the use-a-generality level of behavior (Merrill, 1983). It entailed building an ascending musical interval within the range of an octave up from a given note

with examples. It was presented in a self-contained written booklet. Two forms of each booklet, one treble clef and one bass clef, were provided.

A pilot test was given to high school band musicians at East-Syracuse-Minoa High School. Results of the study prompted the authors to make three changes in the instruction booklet. First, each step of the procedure was expanded into two substeps. Second, the instruction was spread out over more pages of the booklet. Third, for the experimental group, the words "most often made mistakes, can you figure out what's wrong?" were added above the nonexamples.

The instructional booklet indicated the purpose of the instruction: "to teach a procedure for building a musical interval up from any given note." The booklet then presented the following steps constituting the generality of the procedure:

1A. Beginning on the given note, count up the lines and spaces to the number requested.

1B. Write in the note.

2A. Again, begin in the given note, but in this step count up the number of 1/2 steps between the given note and the note requested.

2B. Write the correct sharp or double sharp or flat or double flat, if needed.

One example was given to illustrate the steps of the procedure. Following the generality and example of the procedure, four divergent examples, ranging from easy to very hard, were provided. No practice was given. The two steps, for both the generality and the example, were presented on two pages. The students received a Common Interval Chart (see Figure 1), listing the number of 1/2 steps for each interval to facilitate learning steps 2A and 2B of the procedure.

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Insert Figure 1 about here
- - - - - - - - - - - - - - -

Treatments

The instruction was identical for both groups (experimental and control), with three exceptions. First, in steps 1 and 2 of the generality of the procedure, the control group received only the correct procedure. The experimental group received the cor-

Below is a chart of the common intervals within an octave. It will be useful for completing STEP 2 of the procedure. Use it to correctly identify the number of ½ steps for each interval requested. The specific interval names are listed in the left column, and in the right column the correct number of ½ steps is provided for each interval.

Specific Interval	Number of ½ steps
minor 2nd	1
Major 2nd	2
minor 3rd	3
Major 3rd	4
Perfect 4th	5
Augmented 4th or diminished 5th	6
Perfect 5th	7
minor 6th or Augmented 5th	8
Major 6th	9
minor 7th	10
Major 7th	11
Octave	12

Figure 1. Common Interval Chart

rect procedure and a general statement of the common error, plus the reminder "be careful" followed the most often made mistake for the step (see Figure 2). The most often made mistakes, a form of common error, were determined by Macomber, in his independent learning instruction of a procedure, plus an additional content expert.

- - - - - - - - - - - - - - -
Insert Figure 2 about here
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Second, in the example with the generality of the procedure, the control group received only an example of the correct procedure. The experimental group received the example of the correct procedure matched with the most often made mistake (a nonexample, see Figure 2). Third, following the generality and example of the procedure, in the four examples that were provided, the control group received only examples of the correct procedure. The experimental group received the same examples of the correct procedure matched with the most often made mistakes (a form of nonexample, see Figure 3). No practice was provided.

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Insert Figure 3 about here
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Tests and Measures

A prerequisite test of 9 questions on the basic elements of music was combined with a 3 question pretest. A pool of pretest questions was stratified easy-medium-hard, and one example was randomly selected from each difficulty level. The posttest contained 8 questions (see Figure 4) For the instruction and posttest the examples were stratified easy-medium-hard-very hard, and an equal number of each was selected at random from each pool.

In the pretest and posttest, students were simply asked to "build a specific interval up from the given note" (use a generality).

- - - - - - - - - - - - - - -
Insert Figure 4 about here
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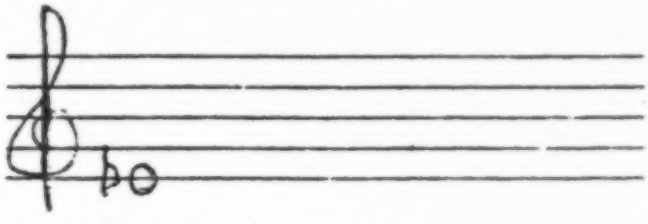
STEP 1A. Beginning on the given note, count up the lines and spaces to the number requested.

BE CAREFUL: Begin counting on the given note and NOT the line or space above it. This is the most often made mistake.

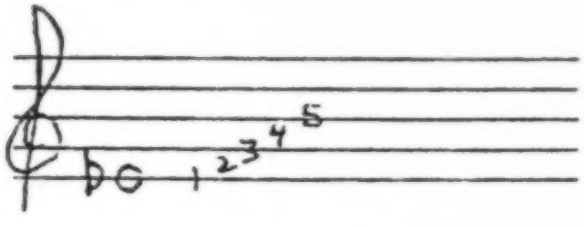
STEP 1B. Write in the note.

EXAMPLE: Build a Perfect 5th up from the given note.

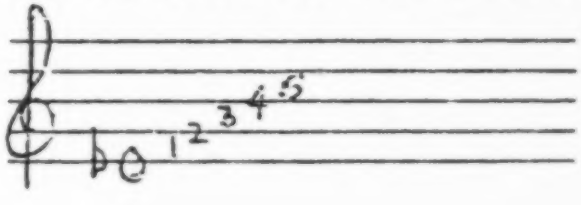


A) Count up 5 lines and spaces.

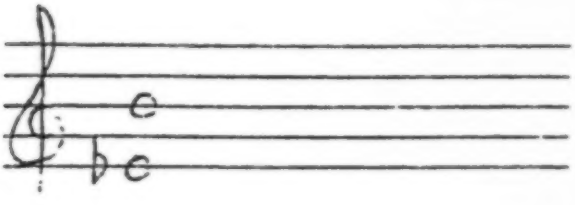
CORRECT EXAMPLE

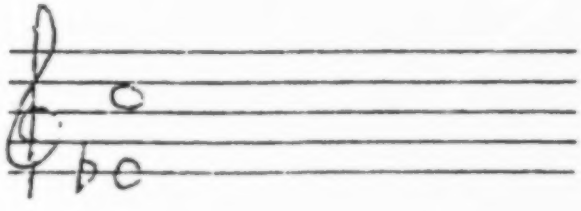


THE MOST OFTEN MADE MISTAKE.
CAN YOU FIGURE OUT WHAT'S WRONG?



B) Write in the note.





In this example, now that we know the correct interval will be a form of the note B we may go on to step 2.

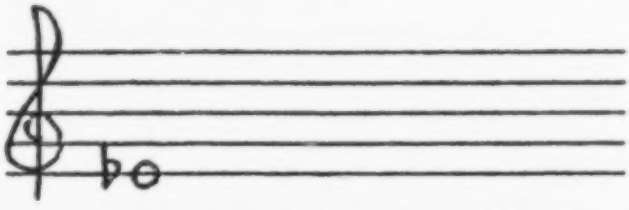
Figure 2. Procedure for Building a Musical Interval up from the Given Note

STEP 2A. Again, begin on the given note, but in this step count up the number of ½ steps between the given note and the note requested. To make this easier, we have included a Common Interval Chart to help you correctly identify the number of ½ steps for each interval.

STEP 2B. Write in the correct sharp or double sharp, or flat or double flat if needed. When counting, it is important to remember that the distance between the notes E and F and B and C are ½ steps.

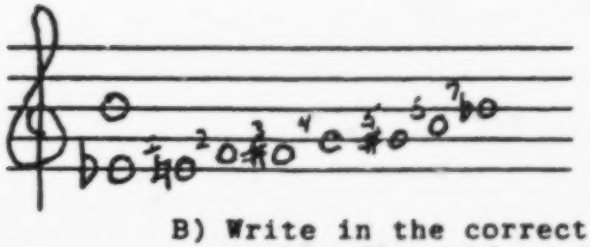
BE CAREFUL: If the given note is a sharp or flat, be certain to begin counting on that specific note and NOT the natural note. This is the most often made mistake.

EXAMPLE: Build a PERFECT 5th up from the given note.

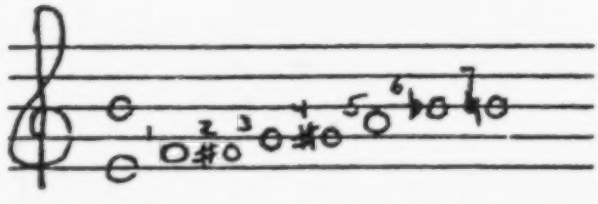


A) On the Common Interval Chart, locate the number of ½ steps a PERFECT 5th has and then count up the correct number of ½ steps. 7 is the correct number of ½ steps for a PERFECT

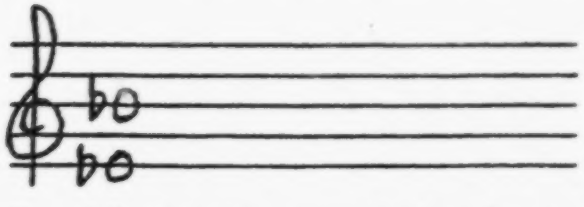
CORRECT EXAMPLE

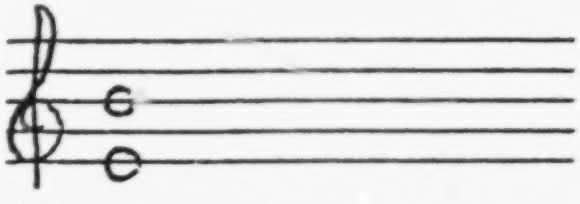


THE MOST OFTEN MADE MISTAKE.
CAN YOU FIGURE OUT WHAT'S WRONG?



B) Write in the correct sharp or double sharp, or flat or double flat (if needed).

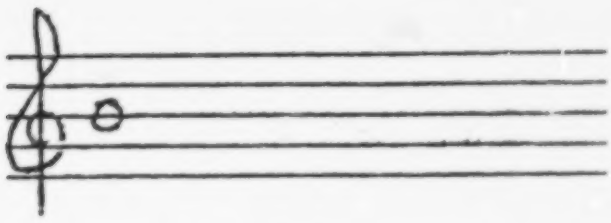




Now if you are uncertain about any of the steps of the procedure, go back and review before going on to the examples.

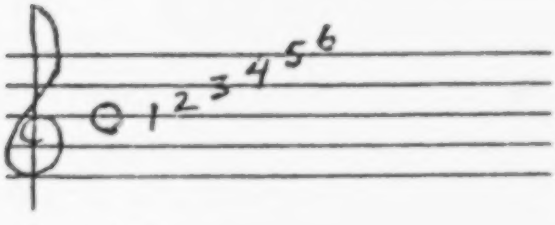
Figure 2. (cont.)

EXAMPLE 2. Build a minor 6th up from the given note.

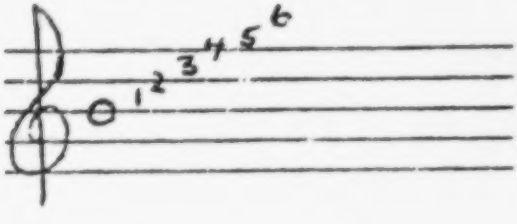


Step 1A

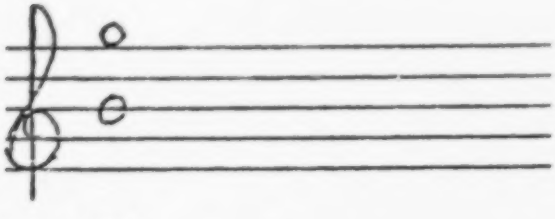
CORRECT EXAMPLE

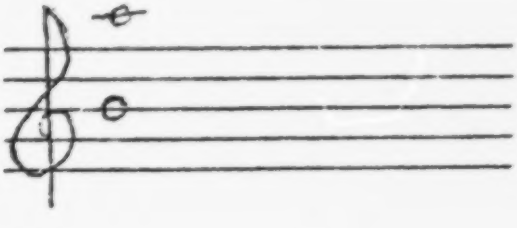


THE MOST OFTEN MADE MISTAKE.
CAN YOU FIGURE OUT WHAT'S WRONG

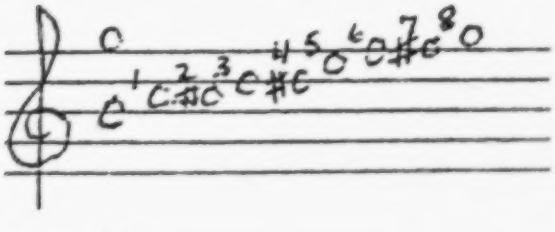


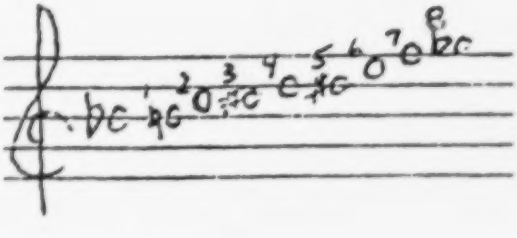
Step 1B



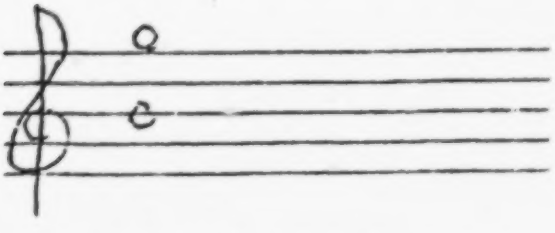


Step 2A





Step 2B



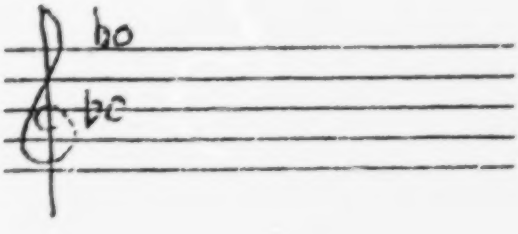
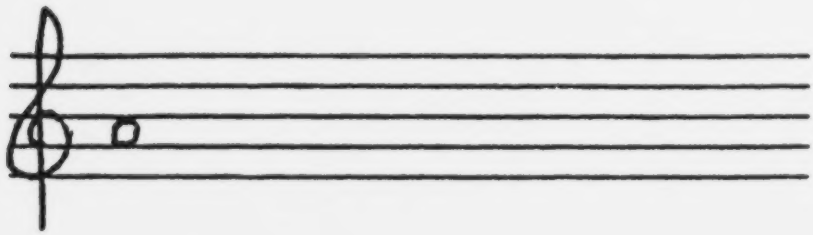


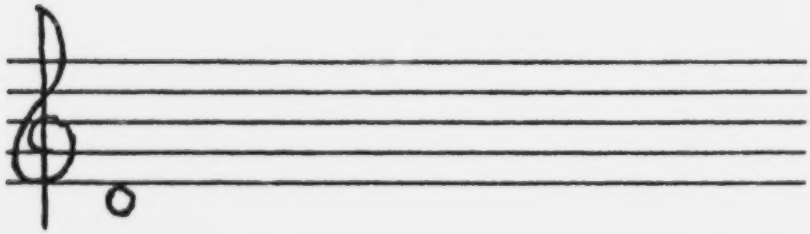
Figure 3. Example

Following there are eight questions that will ask you to build an interval up from the given note. You may use the Common Interval Chart but MAY NOT go back to the instruction booklet to review the procedure. You may use pencil or pen. Please DO NOT ask any questions as NO questions may be answered. Answer all questions on the paper.

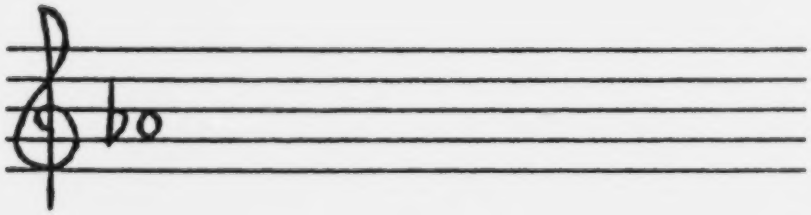
1. Build a minor 3rd up from the given note.



2. Build a Major 7th up from the given note.



3. Build a minor 6th up from the given note.



4. Build a diminished 5th up from the given note.

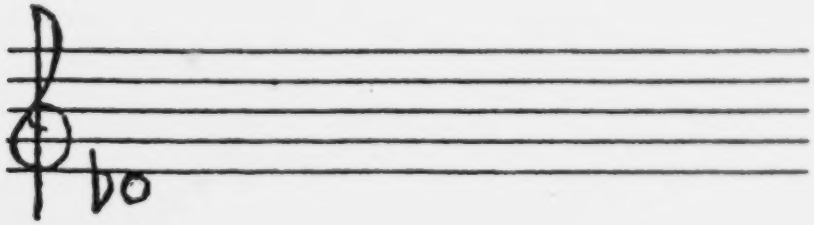
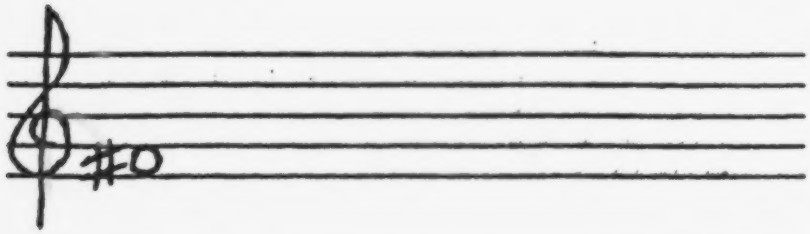
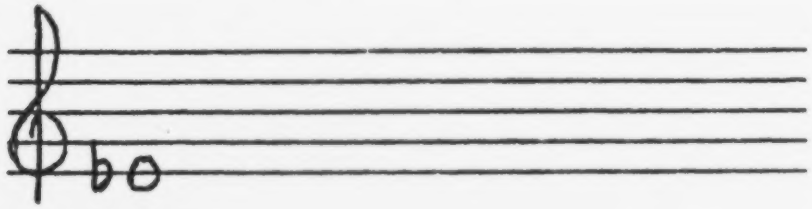


Figure 4. Posttest

5. Build a minor 3rd up from the given note.



6. Build an Augmented 5th up from the given note.



7. Build a diminished 5th up from the given note.

8. Build an Augmented 5th up from the given note.

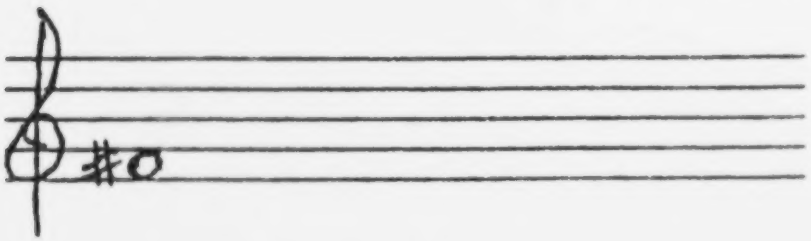


Figure 4. (cont.)

Procedure

The students were asked to participate in the study, requiring approximately 30 minutes of the normal rehearsal time. No payment or grade was associated with the study. However, immediately prior to the administration of the study, students were encouraged to do their best, and were told that the content of the study will be useful in the further development of their musical knowledge.

Immediately following the pretest the 2 forms of the instruction booklet were randomly assigned to the students in equal amount by a numerical draw. All instruction was in written presentation. Students were instructed to read the booklet carefully, and when they were ready to proceed, flipped over the booklet and completed the 8 question posttest. They were allowed to use the Common Interval Chart, but were not allowed to go back over the instruction or examples. 30 minutes were provided in all.

Results

1. A t-test was performed on both the pretest and prerequisite test to test for equivalence of groups (see Table 1). There were no significant differences on either test. The range of the prerequisite test scores (11.0 to 14.0 out of 13) showed that the students had prerequisite knowledge.

- - - - - - - - - - - - - - -
Insert Table 1 about here
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2. A simple t-test was performed to test any differences between the control and experimental groups on the posttest. No significant differences were found (see Table 2).

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Insert Table 2 about here
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3. The experimenters felt that differences in pretest scores might be controlled by using the pretest as a covariate to reevaluate posttest differences. A one-way analysis of covariance was therefore performed (see Figure 5), but no

TABLE 1

Comparison of Pretest Scores by Group

Group	n	Mean	SD
Control	12	1.17	1.03
Experimental	12	0.67	0.65

(t = 1.42, P = 0.17)

Comparison by Prerequisite Scores by Group

Group	n	Mean	SD
Control	12	13.08	0.90
Experimental	12	13.33	1.07

(t = -0.62, p = 0.54)

TABLE 2

Comparison of Posttest Scores by Group

Group	N	Mean	SD
Control	12	4.00	2.41
Experimental	12	3.75	2.70

(t = 0.24, P = 0.81)

significant differences were found on the posttest (F = 0.12, p = 0.73).

- - - - - - - - - - - - - -
Insert Figure 5 about here
- - - - - - - - - - - - - -

4. A similar model was constructed using prerequisite scores instead of pretest scores as a covariate. However, no correlation existed (r = -0.094, P = 0.77) between posttest and prerequisite scores, showing that prerequisite scores were inappropriate as a covariate (see Figure 6).

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Insert Figure 6 about here
- - - - - - - - - - - - - -

Discussion

The results of this study revealed no significant difference in performance as a result of the presentation of common errors in instruction for procedure learning at the application level. The results of this study provided the following:

1. The prerequisite scores revealed that students had the appropriate knowledge to learn the procedure.

2. The pretest scores showed that prior knowledge was not a significant factor to confound the study.

3. A good distribution was found in the posttest scores for both groups; however, no significant difference was found between control and experimental groups.

4. Initial results indicated that there might be a significant difference between pretest and posttest scores within the experimental group. However, a one way analysis of covariance, using the pretest scores as a covariate, failed to reveal significant differences.

Given the above observations, the authors suggest that the absence of significant differences was due to the following:

PLOT OF POST TEST BY PRETEST SCORES

FOR EACH TREATMENT

REFERENCE LINE IS LINEAR REGRESSION
FOR APPROPRIATE GROUP

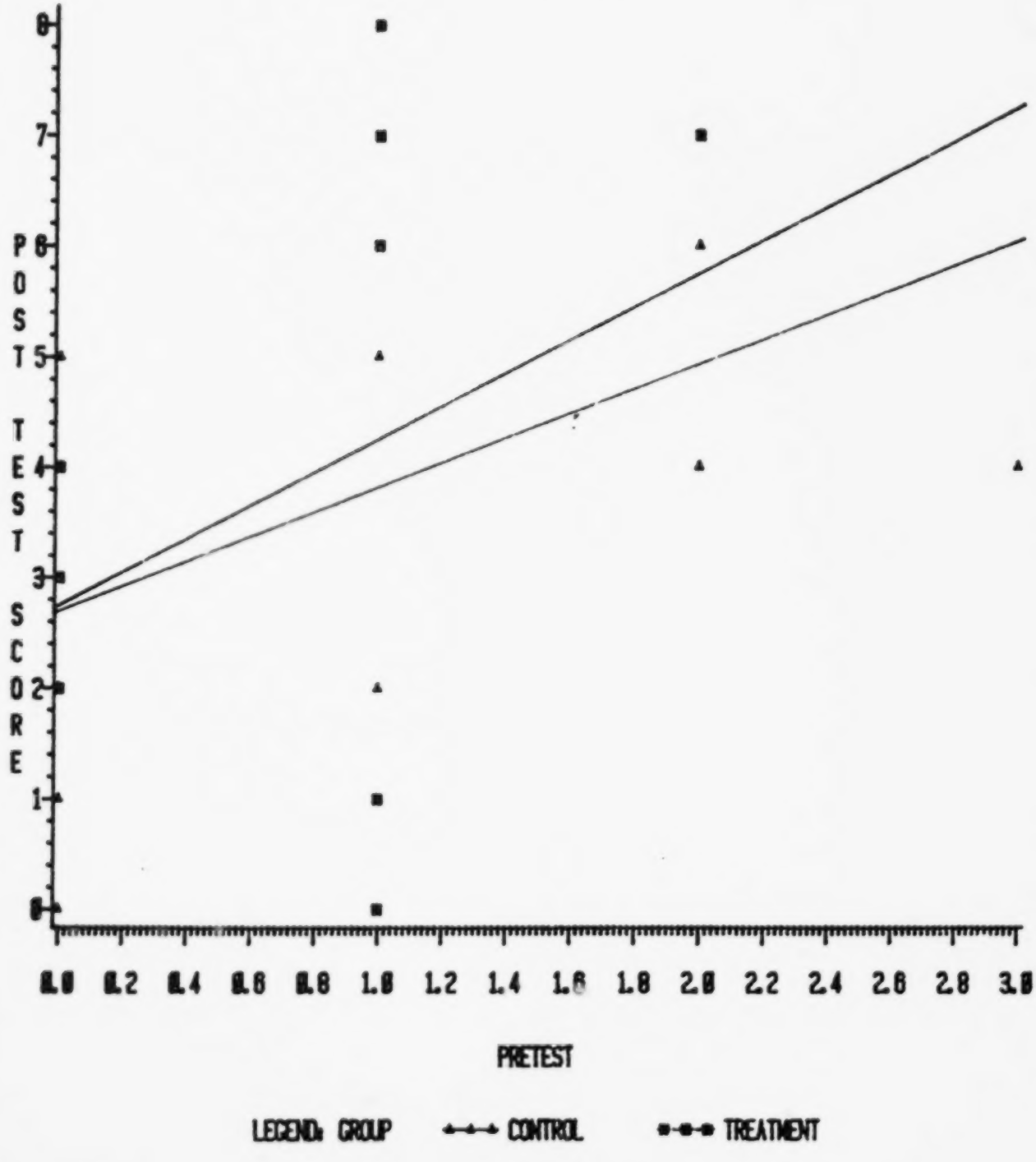

Figure 5

PLOT OF POST TEST BY PREREQUISITE SCORES

FOR EACH TREATMENT

REFERENCE LINE IS LINEAR REGRESSION
FOR APPROPRIATE GROUP

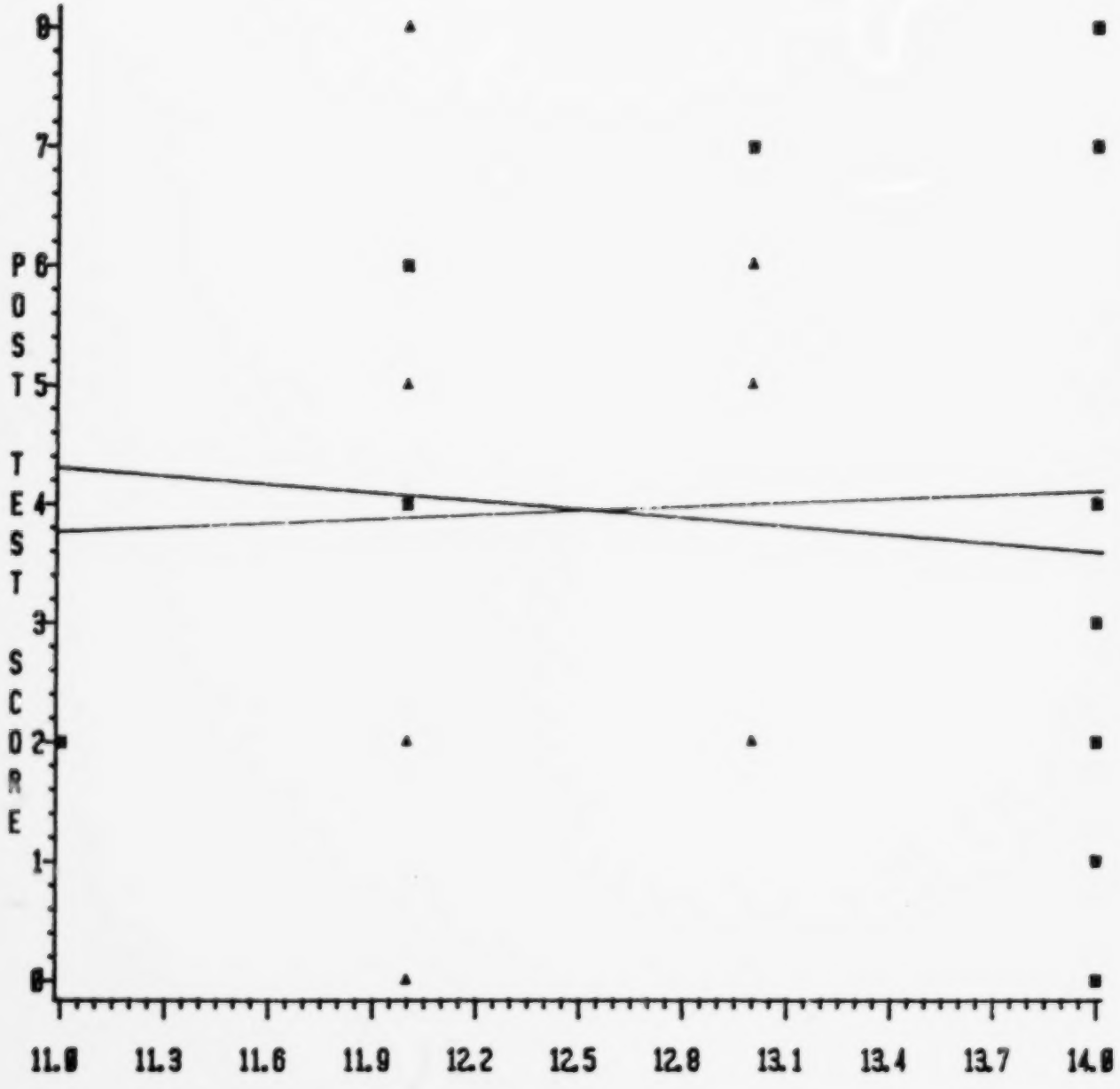

Figure 6

1. It appears that the experimental instruction booklet may have lacked treatment power, although the authors enriched the instruction after the results of the pilot study.

2. The positive results of Bentti, Golden and Reigeluth (1983) appear to have been made detectable by the use of a paced audiovisual presentation that controlled the amount of effort students spent on each step of the procedure. It forced all students to spend an equal amount of time to looking and listening to the common errors for the generality and examples. In the present study, due to the written presentation form, this important variable was not able to be controlled. This difference in studies could possibly be an important reason why no significant differences was found between groups in the present study.

Because it seems likely that the lack of control of effort made any effects of common errors undetectable, the authors still propose that:

1. Presentation of common errors of varying difficulty is beneficial for teaching procedures

2. Common errors should be errors commonly made for the procedure.

3. The use of common errors is most valuable when the common error is made apparent.

Further research is needed to determine the value of matched examples and nonexamples for teaching a procedure. In conducting such research, particular care should be taken to properly enrich the instruction, and to control the amount of effort.

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